NEED FOR NATION-WIDE REVISION IN MECHANICAL DRAWING CURRICULUMS TO MEET METRIC STANDARDS

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CHAPTER I

INTRODUCTION

Concurrent with the advancement of our amazingly complex technology, drafting as a non-verbal technical language developed as one of the most important occupations in the society. Few industries, regardless of what they are producing, can survive without some drafting capabilities and facilities. For example, in manufacturing very simple machines and structures such as potato peelers, sewing machines, radio sets, and bridges or very complex machines such as nuclear submarines, numerical control machines, or space capsules, detailed drawings must be made to give the exact physical dimensions and the required specifications of each part. Therefore, the demands for draftsmen are increasing remarkably. According to the "Occupational Outlook Handbook" (22, p. 226):

> An estimated 310,000 draftsmen were employed in 1970 . . . about 9 out of 10 draftsmen are employed in private industry . . . Over 20,000 draftsmen worked for Federal, State and Local Governments in 1970. Of those employed by the Federal government, the large majority worked for the Department of the Army, Navy and Air Force.

The relative demand for skilled draftsmen is said to be increasing. Concerning this matter, the Division of Research, Planning and Education of Oklahoma State Department of Vocational and Technical Education (7) projects that the employment opportunities for draftsmen are expected to be favorable through the 1970's. Prospects for those having completed post-high school drafting training also were shown to be promising.

Well-qualified high school graduates who have had only high school drafting, however, also were indicated to be in demand for some types of jobs. The employment of draftsmen is expected to rise rapidly as a result of the increasingly complex design problems of modern products and processes.

Though there will be an increasing demand for draftsmen, industry expects that those drafting graduates to be employed will have the skills and knowledge which are required for satisfactory job performance. If industries, in general, incorporate specific methods or systems in the production of their drawings, the schools must act accordingly and incorporate these systems into their operation in order to meet the industry's demand and the individual's need.

Statement of the Problem

A recent trend within industries of the United States seems to be a move toward the commitment to, and adoption of, metrification. It appears that the metric system will eventually become the sole standard of weights and measures in the United States and, consequently, mechanical drawings for many industries will be produced with metric specifications in the near future. The problem with which this study is concerned is the lack of specific information regarding the extent to which industry is presently using, or planning to use, metrics in its drafting operations and what industry expects in this regard from schools preparing draftsmen.

Importance of the Study

The move toward changing to the metric system is relatively new in the United States. It is felt, therefore, that this study will be of considerable importance specifically to educators and educational decision makers. This study will provide sufficient information about the industries' move toward the utilization of metrics to lay the foundation upon which decisions can be made relative to the revision of the existing mechanical drawing curriculums. Without a study of this kind, it would be difficult for the schools to ascertain what the demands of industry are and whether or not drafting curricula are relevant to the needs of industry.

Objectives

The objectives of this study are:

1. To determine the extent to which industry has incorporated metrics into its operation presently and the extent to which industry will be using the metric system in their drawings five years from now.
2. To determine the degree to which industry drawings currently are being produced with metric specifications and the relative increase expected in the utilization of metrics drawings five years from now.
3. To determine the degree to which companies are conducting in-plant training programs for orienting their employees in the use of the metric system.
4. To determine the extent to which industry wants their employees

to receive metrics training in schools prior to employment in industry.

5. To determine if industry feels that the schools are preparing their drafting students with appropriate skills in the use of metrics.

Scope of the Study

This study included drafting departments of major manufacturing industries identified in the Thomas Register of American Manufacturers. The companies surveyed for this study represented those companies which produce and use technical drawings in their operation. It did not include those companies which use drawing other than mechanical drawings. The size of the companies under the study was determined from the number of the draftsmen employed by each company, that is 1) less than five draftsmen, 2) five to ten draftsmen, 3) eleven to fifteen draftsmen, and 4) sixteen or more draftsmen.

CHAPTER II

REVIEW OF LITERATURE

The Emergence of the Metric System

The metric system of measurement originated with a Frenchman, Gabriel Mouton, who for the first time developed and introduced a decimal system which was based on units of ten as early as 1670 (16). At that time, Eurpoe, except for England, had no uniform system of measurement. Weights and measures differed not only from country to country, but even from town to town and from trade to trade. The National Assembly of France, due to the difficulties encountered in their daily commercial transactions, felt the need for a uniform system of measures and authorized the French Academy of Science to develop a standard for all mearures and all weights. The French Academy of Science further developed Gabriel Mouton's decimal system to the early form of the present metric system. The newly developed measurement system was then adopted by the National Assembly of France in the year 1705 (16), but its use was not made compulsory until 1840 (13).

Adoption of the metric system progressed in France and ultimately spread to the neighboring countries. By the year 1900, most European countries as well as Central and South American countries were using metrics in their daily operation. Since then, the number of countries converting to the metric system has increased greatly. The Soviet Union and China made use of the metric system mandatory shortly after the end

of World War II. India and Japan converted to metrics in the 1950's. Great Britain began a ten-year conversion to the metric system in 1955 and, within the last few years, the remaining major nations of the British Commonwealth, Australia, Canada, and New Zealand have begun the conversion to metrics. Presently, the United States is the only major industrial and commercial country, in a world of metrics, that uses some other measurement system (16).

Use of the metric system in the United States was actually legalized under a Congressional act in 1866. The United States and sixteen other countries met in Paris in 1870 and signed an international treaty, "Treaty of the Meter," and established metric standards which led to the establishment of the International Bureau of Weights and Measures in 1875. Following that, in 1890 President Harrison officially received meter number 27 and kilogram number 20 as the accepted standards (13). Three years later, in 1893, the Secretary of the Treasury announced that the fundamental standards of length and mass would be the meter and kilograms standards kept in a vault at the Office of Weights and Measures in Washington, D.C. All United States customary units since that time have been exact ratios of those standards (16). In 1902, a bill which would make use of the metric system mandatory within federal government works was defeated by Congress (13).

Economic Feasibility

Most of the countries in the world have accepted the metric measurement system because it is simpler to figure and easier to handle in all fields of our present technology. The United States, as an integrated part of the world, very recently has found that it will be

economically beneficial to the nation as a whole to change the traditional English system into metric. Concerning some of the economical factors, Business Week (1, p. 106) in its issue of June 9, 1973, carried an article disclosing that:

> U.S. Industry today uses a 2-million different fastners with an annual installed value of $10 billion. Ford Mallen estimates that an agreement on a single international system of nuts, bolts, screws, and revits would produce a saving of $500 million.

It is believed that changing to the metric system may not cost as much as an outsider may think. Ford Motor Company (10), by adopting the metric system, experienced that in most cases the standard inch machines needed only minor adjustments to produce metric parts. In the area of design, to assure that all product engineering design and manufacturing activities would be worked with the same parameters, the product-engineering office prepared a metric practice manual as a guide for those activities. Among the design parameters used were: design in metric modules, use of millimeter as the only expression of length, and retaining the practice of using third angle projection. In the manufacturing area also the necessary change indicated was small. For example, the incline transfer machine is typical of the highly automated high-production equipment in an engine plant. These machines were designed and built entirely to customary inch measurements except for the tooling. At one machine station, the only area affected by metrication was the one that directly affected the product. Metrics was applied only to the tool's surface. With reamers and drills, the length and shank end were retained in inches, using inch blanks. Because the shank end was in inches, the collets used in the holder did not have to change. Only the tool's cutting surface and the bushing's guiding surface were affected. Splines were positioned in metric modules, but the units were

standard American equipment. In grinding and milling, the grinding wheels were in U.S. sizes and only the wheel dressing attachments were made to metric measurements. Changes also were minor in producing metric milling cutters.

Government Inovlvement in Metrification

In a legislative message to Congress, President Nixon (21, p. 57) urged action on metrification:

> Americans cherish tradition in our own way of doing things, having been aculturated from childhood to the concept of an inch, a mile, or a pound, we are understandably non-plaused when we consider the notion of centimeter, a kilometer, a gram or a kilo . . ., we must conclude, however sadly, that we are the ones . . . out of step . . . I have recommended to the Congress that it pass legislation to convert America to the metric system . . . I am pleased to note that the administration's proposal is presently before the appropriate House sub-committee. I ask that the Senate give equally expeditious consideration to effecting this necessary change.

As indicated above, the aura of inevitability about metrification comes in part from governmental moves. In 1971, a three-year study by the National Bureau of Standards concluded with the recommendation that the United States change to the international metric system through a coordinated national program over a period of ten years. That recommendation is now official government policy and has been endorsed by the President of the United States.

In a report entitled "A Metric America: A Decision Whose Time Has Come," the Secretary of Commerce (19) recommended to Congress a systematic, nationally coordinated, United States changeover to the metric system of measurement over a ten-year period. The report, prepared by the National Bureau of Standards, in accordance with the Metric Study Act of 1968, represents the result of three years of studies, surveys,

and analysis by the Bureau. It represents the cooperation of thousands of individuals and organized professionals as well as educational, business, labor, and consumer groups throughout the country.

In releasing the report, Secretary of Commerce, Maurice H. Stans, admitted that for many years this nation has been slowly going metric, and it would continue to do so regardless of national plans and policies. At the same time, the world-wide use of the metric system is increasing and, today, ours is the only major nation which has not decided to take such a step. As the report states, a metric America would seem to be desirable in terms of our stake in world trade, the development in international standards, relation with our neighbors and other countries, and national security. The Secretary endorsed the report's basic conclusion in favor of going metric and made the following recommendations (19, p. 4) to Congress in July, 1971.

1. That the U.S. change to the International Metric System deliberately and carefully.
2. That this be done through a coordinated national program.
3. That the Congress assign the responsibility for guiding the change to a central coordinating body responsive to all sectors of our society.
4. That within this guiding framework, detailed plans and timetables be worked out by these sectors themselves.
5. That early priority be given to educating every American school child and the public at large to think in metric terms.
6. That in order to encourage efficiency and minimize the overall costs to society, the general rule should be that any changeover costs shall lie where they fall.

7. That the Congress, after deciding on a plan for the nation, establish a target date ten years ahead, by which time the U.S. will have become predominately, though not exclusively, metric.
8. That there be firm government commitment to this goal.

According to item number seven of the plan, a target date now generally accepted by the state and federal education officials is the year 1980 (23). At that time, they probably will be demanding instructional materials in metric measurements. The U.S. Office of Education is funding projects aimed at helping to achieve conversion in vocational and technical, as well as elementary and second education, by that date.

The Congress passed the first official legislation concerning conversion to the metric system as part of public law 93-380 (9), to extend and amend the Elementary and Secondary Education Act of 1965. This provision was signed into law on August 21, 1974 and included under section 403 of the law, a portion entitled "Education for the Use of the Metric System of Measurement." Based on this fact, Congress authorized an appropriation to the Commissioner of Education in the amount of $10 million for each of the fiscal years ending prior to July 1, 1978. In July, 1974 the United States Office of Education awarded a contract for a three year project to develop curriculum materials for student use in vocational and adult education and with elementary and secondary teachers (23).

Industry's Prospects

Progress toward the 1980 metrification target, in general is satisfactory so far and many sectors of industry have worked out their own programs of change and are implementing them.

Actually, there is no need to legalize the metric system -- that was done in 1866. In 1893, America officially became a metric nation. More important than any government recommendation is the little realized fact that the United States is going metric now -- about 30 percent of the industry has already converted to metrics (12). NASA started metrification in 1963 and has been using metrics exclusively since 1970. The United States pharamaceutical industry has used only metric units for nearly two decades. International Business Machines announced in 1972 that it was starting a ten-year program that would make metric units its predominant measurement system. Caterpiller Tractor Company started metrication by establishing a dual system and Caterpillar's 10,000 suppliers were given conversion charts. New equipment is being designed in the metric system and all new machinary and tools are metric (8). Business Week (1) reveals that Ford Motor Company built the first automotive plant in the United States designed specifically and exclusively to build products to metric specification. Likewise, Machine Tools Industires in the United States is implementing metric measurements on their products.

An article published in Machine Design (11) concerning General Motors' standing on the metrication matter indicates that the rate of conversion to the metric system within General Motors will be governed by the release of new parts, metrically dimensioned, and by the normal phasing out of "in-production" parts. Edward N. Cole, General Motors' president, has stated that his company has set up a guide line which will be followed. The General Motors' guide line includes:

1. New development will be metric from the start, including items now in the development stage.

2. Service parts now in production will remain as they are.
3. Supplier coordination will be implemented as required.
4. In the interim, before complete metrification, some capital equipment with dual measuring capability will be required.

According to Clyde Eby (1), the Customer Service and Quality Assurance Manager at Cincinnati Milacron Incorporation, metric measuring devices have for years been installed on machine tools that the company makes for export, and some are sold domestically. S-K, a major maker of auto-mechanics' wrenches reveals that 36 percent of the loose sockets they sell are metric since 23 percent of all cars now in use plus most bicycles and motorcycles have metric parts. Timken Company (12) in Canton, Ohio began its move to the metric system in 1962. Deere & Company in Waterloo, Iowa changed to the metric system thriteen years ago. In regard to the drawing production, since 1973 all new drawings have been in the metric system with computer-generated customary printouts in the corner of the drawing. On a similar basis, Rockwell International Corporation in Pittsburgh adopted the metric system into their operation in January, 1974. It will take the corporation about ten years to make the use of metrics predominant in all its divisions. Similar to Deere & Company, Rockwell International uses only metric dimensions, but it includes computer-generated inch conversion in a chart on each drawing.

Opinion Poll

A June, 1974 opinion poll (25) shows that 90 percent of the respondents were in favor of adoption of the metric measurement system. Seventy-four percent of those answering felt that the metric system in

the United States should be mandatory in all industires. Also, 56 percent felt that the United States world trade has already been affected directly by its postponing metric conversion.

CHAPTER III

METHODOLOGY

The primary purpose of this study was to ascertain the extent to which the United States industries have deleted or plan to abandon their use of English system of measurements in favor of the international system of measurements (SI).

The needed information sought by this study, as indicated in the problem statement, is descriptive in nature and requires an analysis of the action taken by industry toward the adoption of metrification.

Instrumentation

Due to the nature of this study, it was decided that a questionnaire would be the best means of collecting the necessary data. A nine item questionnaire was then carefully developed and mailed to the chief draftsman of selected companies.

Questionnaire

Brainstorming method was employed in developing the questionnaire. First, a number of relevant questions that would presumably have gathered the necessary informations were developed for each of the prescribed objectives and it was then finalized by selecting more appropriate items which assumingly best served the purpose. Items were selected mainly from the stand point of their face validity and construct

validity. The questionnaire was not pre-tested for its content validity, however, as the result of the question number one of the questionnaire compared with the result of a somewhat similar study conducted in current year it seemed to be highly valid. Though this analogy does not lead us to conclude that all the items of the questionnaire were equally valid, but it may lead to believe that the rest of the questions may have given equally well consideration.

Population

Names and addresses of the companies have been complied basically from two sources:

1. Names of firms within the state of Oklahoma which employ draftsmen were obtained from Oklahoma State University Technical Institute, Oklahoma City.
2. Names and addresses of manufacturers outside Oklahoma were obtained through Thomas Register of American Manufacturers, 60th Eddition, 1970.

Questionnaires, accompanied by a stamped envelope with return addresses, were mailed to 103 companies throughout the United States in order to gather relative information with regard to the problem under consideration. Though these companies were not randomly selected, their diversity in size and type of product made the sample relatively broad.

Analysis of Data

The data obtained from each of the questionnaires has been tabulated and statistically analyzed. From this information, a number of conclusions were drawn.

CHAPTER IV

REPORT OF THE SURVEY

As stated in a previous chapter, the primary aim of this study was to ascertain the extent to which industry has succeeded in incorporating the international system of metrics measurement into its technical drawings and the extent to which it will be using the system in the future. The purpose of this chapter is to present the results of the investigation.

Sources of Data

As it was mentioned in the previous chapter, the questionnaire method was employed to acquire the data for this study. The primary purpose of the questionnaire was: to acquire an accurate picture of the existing status of industry as well as the future planning of industry in relation to metrification, through which the industry's needs could be assessed. This assessment of needs will then be used as a source of information for those schools which train students in the field of drafting.

By obtaining this information, schools will be better able to determine the necessity for revision in mechanical drawing curriculums with regard to the international systmes of measurements.

Administration of the questionnaire: A questionnaire accompanied by a letter of transmittal and a self-addressed, stamped, return envelope

was mailed to 103 companies throughout the United States on September 5, 1975. A followup letter was mailed to those companies which had not responded within twelve days of the first mailing of the questionnaire. Copies of the questionnaire and inquiry letter are in the Appendix. Also in the Appendix is a copy of the followup letter which was mailed on September 17, 1975.

Nature of the Responses

The nature of responses, which are the bases of this study, is shown in tabular form Table I illustrates that from a total of 103 questionnaires mailed, nine of them, due to incorrect addresses, failed to reach their intended destination. This left a total of ninety-four questionnaires which, presumably reached the addressee.

TABLE I

QUESTIONNAIRE RETURN INFORMATION

Number of questionnaires mailed	103
Number of questionnaires which failed to reach their intended destination	9
Net total of questionnaires which presumably reached their destination	94
Number of questionnaires returned	71
Percent of returned questionnaires	75.5
Number of incomplete returned questionnaires	5
Number of processable questionnaires returned	66

As Table I illustrates, from the 94 questionnaires, 71 questionnaires were returned which gives a response of 75.5 percent. It was found that of the 71 questionnaires returned, five were incomplete leaving 66 which were complete and processable.

It is also of importance to mention that the majority of the responses returned were from smaller-size companies, employing less than five draftsmen. These constituted 68 percent of the total 71 responses. The larger-size companies, which in this study are grouped under three categories according to the number of their draftsmen, represent 32 percent of the total combined responses.

Survey of Data

The data from the questionnaires are divided into three major areas. These are: 1) Industry's present status, 2) Industry's future prospects, and 3) Industry's perceptions of adequacy of school drafting programs.

The data in this report are reported for the most part in tabular form. Responses to the questionnaire are listed according to frequency of occurance and percentages are determined for each area of concentration.

Industry's Present Status

Table II shows that of the total of 66 companies whose data is used, 18 of them, which comprise 27 percent of the total, have already adopted the metric system in the production of their mechanical drawings. This figure is supported by a somewhat similar study made in the current year which was described in the Review of the Literature. The results reported from that study indicated that "about 30%" of U.S. industry

TABLE II

DISTRIBUTION OF COMPANIES USING AND THOSE NOT USING SI PRESENTLY

Company Classification (No. of Draftsmen)	Companies using SI	Companies Not using SI	Number in Classification	% of Total
Less than 5	11	34	45	68
5 - 10	2	5	7	11
11 - 15	1	4	5	7
16 or more	4	5	9	14
Total Companies	18	48	66	100
%of Total	27	73		

has already converted to the metric system. Also, 48 companies in the current study, which make up the other 73 percent, indicated that they have not yet made use of the international system of measurements in their activities. Table II also shows the distribution of responses returned by each group of the companies.

The information in Table III is recorded in terms of percentages of respondents answering the questions relative to the percentage of drawings produced in the metric system. For example, 22.2 percent of the companies revealed that at the present time less than 25 percent of their mechanical drawings are produced with metric specifications. Further, 1.5 percent of the responding companies indicated the use of metrics on 25 to 50 percent of their drawings. And still another 1.5

TABLE III

NUMBER AND PERCENTAGE OF COMPANIES WHICH CURRENTLY PRODUCE DRAWING IN METRICS (SI)

Company Classification (No. of Draftsmen)	Percentage of Drawings				
	Less than 25%	25-50%	51-75%	75% or more	Total
Less than 5	9	0	1	1	11
5-10	2	0	0	0	2
11-15	1	0	0	0	1
16 or more	3	1	0	0	4
Total	15	1	1	1	18
% of Total (66)	22.2	1.5	1.5	1.5	27

percent showed the production of 51 to 75 percent of their drawings with metric dimensions. Only 1.5 percent of the companies currently produce more than 75 percent of their drawings with metric specifications and have abandoned the English system of measurement almost totally in favor of the metrics.

Industry's Future Prospects

In the previous paragraphs, the present status of industry in the adoption of the metric system was discussed. The purpose of the following paragraphs is to indicate the plans of industry for future changes to metrification. From the responses returned, it was found that 48

companies regardless of size answered "no" to the question, "Does your company presently use the metric system (SI) in its drawings?" As Table IV illustrates, 19 of the 48, or 40 percent, indicated they do plan to convert to the metric system in the future. It is important to note that from the remaining 60 percent who have no plan for changing to

TABLE IV

DISTRIBUTION OF INDUSTRIES' FUTURE PLANS

Company Classification (No. of Draftsmen)	Company Plans for Converting to SI			
	Not Using SI	Planning to Convert to SI	No Plan to Convert to SI	No Plans to Convert but some use of SI indicated
Less than 5	34	10	24*	14
5-10	5	3	2	0
11-15	4	2	2	1
16 or more	5	4	1	0
Total	48	19	29	15
% of Total (48)	100	40	60	31
% of Total (66)	73	29	44	21

* Fourteen of which will be using SI in their drawings to certain degrees.

metrics, 31 percent felt that they will use the metric system despite their currently having no plan for it. This indicates that 71 percent

of those who are not using the metric system now will be using it in one way or another in the future; that is, within five years from now. Table V provides relative information on the distribution of conversion to the metric system as it is planned in the following years. As can be seen, 10.5 percent have plans to incorporate the international system of measurements into their operation as soon as next year. Five and one-half percent will adopt the system in 1977. Similarly, 26 percent, 5.5 percent, 10.5 percent and 42 percent of the companies will adopt the metric system in 1978, 1979, 1980 and 1981, respectively. Based on this fact, Table VI provides information relative to the accumulated percentage of the companies who will be switching over to metrics in each consecutive year. As is illustrated in Table VI, 30 percent of the industries will adopt the metric system in 1976 and by the end of the year 1977, it will increase to 31.5 percent. A big increase is shown in 1978, a net increase of eight percent which brings the total increase of that year to 39.5 percent. And, consequently, by the end of the year 1981, 56 percent of the companies in this study will have switched to the metric system. This shows a projected net increase of 29 percent over a period of about five years in comparison with the accumulated total of 27 percent of the industries up to 1975. It took the United States industry 109 years (since the legalization of the metric system by a Congressional Act in 1866) to accomplish this 27 percent level. The 29 percent increase expected over the next five years averages to approximately five percent.

TABLE V

NUMBER OF COMPANIES EXPECTED TO INTRODUCE SI TO THEIR DRAFTING DEPARTMENT IN THE YEARS INDICATED

Company Classification (No. of Draftsmen)	Year						
	1976	1977	1978	1979	1980	1981	Total
Less than 5	1	0	0	1	2	10.5	3
5-10	1	0	0	0	1	5.5	1.5
11-15	2	0	1	2	5	26	8
16 or more	1	0	0	0	1	5.5	1.5
Total	0	2	0	0	2	10.5	3
% of Total (19)	5	1	1	1	8	42	12
% of Total (66)	10	3	2	4	19	100	29

TABLE VI

PERCENTAGE OF COMPANIES WHICH WILL BE USING METRICS IN THE PRODUCTION OF THEIR DRAWINGS IN EACH YEAR DURING THE PERIOD 1975-1981

Year	Percentage of Companies		
	Companies using SI	Companies expecting to change to SI	Total percentage
1976	27	3	30
1977	30	1.5	31.5
1978	31.5	8	39.5
1979	39.5	1.5	41
1980	41	3	44
1981	44	12	56

Note: This table does not include those 14 companies that do not have plans for changing over to metric and yet indicated less than 25% of their drawings will be produced with metric specifications.

It would also be of great value to know the percentage of technical drawings expected to be produced in metrics by the industry five years from now. Table VII shows that by the end of 1981, 42 percent of the industry surveyed will produce less than 25 percent of their drawings with metric specifications. By that same year, 17 percent of the industry will produce 25-50 percent of their drawings in metrics, 12 percent of the industry will produce 51-75 percent of their drawings in metrics, and only six percent of the total industry indicated that 75 percent or more of theirs will have metric specifications.

TABLE VII

NUMBER OF COMPANIES AND THE RELATIVE PERCENTAGE OF THEIR DRAWINGS FIVE YEARS FROM NOW

Company Classification (No. of Draftsmen)	Percentage of Drawings in Metrics				
	Less than 25%	25-50%	51-75%	75% or more	Total
Less than 5	17*	7	7	3	34
5-10	5	0	0	0	5
11-15	3	1	0	0	4
16 or more	3	3	1	1	8
Total	28	11	8	4	51
% of Total	42	17	12	6	77

* Fourteen of the total have no definite plans to change to SI, but indicated the use of metric system in their drawings.

Industry's Perceptions of Adequacy of Schools

This portion of the questionnaire sought to determine the industry's opinion about orienting their draftsmen in the use of metrics and their satisfaction with schools' implementation of metrics in their drafting programs. Table VIII shows the frequency of the responses as answered by the respondents. Although 44 percent of the respondents do not believe the schools are adequately preparing their drafting students in the use of metrics, 73 percent seem to be in favor of schools continuing to provide that element in their programs. The other 27 percent felt that industry should train its own employees in the use of metrics. As

Table VIII illustrates, about 12 percent of industry has established inplant training programs to orient their draftsmen in the metric system.

TABLE VIII

INDUSTRIE'S PERCEPTIONS OF ADEQUACY OF SCHOOLS' DRAFTING PROGRAMS

	Classification of Campanies by Number of Draftsmen					
	Less than 5	5 - 10	11 - 15	16 or More	Total	% of Total 66
Number of Companies which Have inplant Training Programs	5	1	1	1	8	12
Number of Companies which Prefer Their Employees to be Trained by Schools	33	5	3	7	48	73
Number of Companies which Prefer Their Employees to be Trained by Industry	12	2	2	2	18	27
Number of Companies which Believe that Schools Do a Good Job in Training Drafting Students in Metrics	10	3	1	4	18	27
Number of Companies which Believe Schools Do Not Do a Good Job in Training Drafting Students in Metrics	21	3	0	5	29	44
Number of Companies which Do Not Know Whether or Not Drafting Schools Do a Good Job	14	1	4	0	19	29

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The intent of this study was to ascertain the extent to which the United States Industry has incorporated metrics into the production of its technical drawings presently and the extent to which it will be using the metric system five years from now. The purpose of this chapter is to provide a summary of the study with conclusions and recommendations.

Summary

After the need for this study was established, an attempt was made to collect the necessary data. A questionnaire was developed and mailed to 103 selected manufacturers throughout the United States. The survey questionnaire was divided into eight basic parts for tabulation purposes. The tabulated data were grouped under three major areas of concern: 1) Industry's present status, 2) Industry's future prospects, and 3) Industry's perceptions of adequacy of schools.

The first area which dealt with the determination of present status of industry in regard to adoption of metric system into its design activities indicated that 27 percent of United States industry has already adopted the metric system in the production of their mechanical drawings. Approximately three percent of the 27 produce more than 50 percent of their drawings in metrics, and the other 24 percent indicated that 50 or less percent of their drawings are produced with metric specifications.

The second area sought to reveal the future prospect of industry regarding adoption of the metric system into their activities. It was disclosed that from the 73 percent of those industries which at the present time are not using metrics in their drawings, 29 percent indicated a sound plan for changing over to metrics within the next five years. Further, 21 percent showed that despite their not currently having plans for switching over to metrics, they will inevitably be using metrics in their designs to a certain degree. The analysis of data reveals that by 1981 about 77 percent of the industries surveyed will be producing at least some of their drawings with metric specifications.

The third area which dealt with industry's perceptions of the schools' adequacy in preparing drafting students in the use of metrics, indicated that 44 percent of industry feels that schools are not training their drafting students with the necessary use of metrics along with their drafting skills. The data further indicates that 12 percent of the industries have established inplant training programs for the purpose of orienting their existing draftsmen.

Conclusions

From the data obtained, and insofar as the respondents are representative of the whole, the following conclusions were drawn.

1. The United States industry will eventually abandon the customary English system in favor of metrics. It seems that by the end of 1981 more than one-half of those industries surveyed will be converted to the metric system and will produce greater percentages of their drawings with metric specifications.

2. It is noted that a greater percentage of industry feels that drawing programs offered in schools are inadequate in terms of metric training and do not meet the needs of industry.
3. It is also apparent that in general a greater percentage of the industries surveyed feel schools are their best option for the purpose of orienting their existing, as well as for training their future draftsmen employees, in the use of metric system.
4. There seems to be some uncertainty among those companies surveyed relative to their converting to metrics. This may result in some reservation among educators for converting their programs to metrics.
5. Industries may look to education to orient their employees to metrics if they have some confidence in the shcools' abilities to do so.

Recommendations

1. Continuous effort be made to disseminate information about industry's practices and needs, and schools offering mechanical drawing programs give equally expeditious consideration to their curricula in order to have them accorded with the individual's and industry's need.
2. It is also recommended that additional consideration be given to this aspect of the study and that continued research using a larger population be undertaken.

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APPENDIX A

Dear Sir:

This survey is being made to ascertain the extent to which industries have incorporated the metric system (SI) in the field of drawing.

By completing and returning this questionnaire, you will be helping us to determine the need for curriculum changes in the field of mechanical drawing to meet the present and the future needs of individuals and industry.

Your promptness in completing and returning this questionnaire will be greatly appreciated. A self-addressed, stamped envelope is included for your convenience.

Truly yours,

Mohammad A. Rashiq
Room 406, Classroom Building
Oklahoma State University
Stillwater, OK 74074

QUESTIONNAIRE ON METRIC UTILIZATION

IN INDUSTRY

The purpose of this questionnaire is to determine the need for including metrics in drafting technician education programs by determining the extent to which employers of drafting technicians are using metrics in their work. Please check the appropriate response to each of the following questions.

1. Does your company presently use the metric system (SI) in its drawings?
   Yes _____ No _____

2. If the answer is yes, approximately what percentage of your drawings is currently produced with metric specifications?
   Less than 25%_____ 25-50%_____ 51-75%_____ More than 75%_____

3. Approximately what percentage of your drawings will be produced with metric specifications within 5 years from now?
   Less than 25%_____ 25-50%_____ 51-75%_____ More than 75%_____

4. If your company does not use the metric system (SI) presently, are there plans for changing over to metrics in the future?
   Yes _____ No _____

5. If yes, when do you expcet to introduce the SI to your drawing department?
   1976_____ 1977_____ 1978_____ 1979_____ 1980_____
   Other (please specify)_____

6. Approximately how many draftsmen are employed in your plant?
   Less than 5_____ 5-10_____ 11-15_____ 16 or more_____

7. Do you have an inplant training program for orienting and training your draftsmen in the use of the metric system?
   Yes _____ No _____

8. Do you prefer to train your employees on the job in the use of metrics or would you prefer that it be done by schools before you employ an individual?
   Industry_____ Schools_____

9. Do you feel that the secondary and post-secondary schools are preparing their drafting students with appropriate drafting skills in the use of metrics to fulfill the needs of industry?
   Yes _____ No _____

APPENDIX B

Dear Sir:

I am writing again to solicit your assistance in conducting a study to determine the extent to which industrial drafting departments have incorporated the metric system in their company drawing.

A questionnaire concerning this survey was mailed to you earlier and you may have already returned it by now. If so, please ignore this letter. I do need your response though and am enclosing another questionnaire in case you have misplaced the first one or it failed to reach your office.

It is realized that by seeking your help in this study we are competing for your time in an already busy schedule. However, by spending a few minutes of your time in checking the responses you will contribute to the continuing efforts to improve vocational-technical education programs.

Sincerely,

Mohammad A. Rashiq
Room 405, Classroom Building
Oklahoma State University
Stillwater, OK 74074

LIST OF THE COMPANIES QUESTIONNAIRES WERE MAILED TO

	Company	Location
1.	Amerand, Inc.	Oklahoma
2.	Armco Steel Corporation	Oklahoma
3.	Ajax Die Casting and Plastic Company	Oklahoma
4.	ARK Foundry and Manufacturing Co.	Oklahoma
5.	Armstrong Brothers Tool Co.	Illinois
6.	American Steel and Iron Workers, Inc.	Colorado
7.	The American Tool Workers Company	Ohio
8.	American Vacuum Company	Illinois
9.	Ames, W., and Co.	New Jersey
10.	American Company Inc.	Minnesota
11.	AMSCO Industrial Company	Pennsylvania
12.	Anchor Bolt and Screw Co.	Illinois
13.	Andco Industiral Corp.	North Carolina
14.	Anderson O. L., Co., Inc.	Michigan
15.	Anderson Tool and Manufacturing Co.	Illinois
16.	Apec Metal Corp.	New Jersey
17.	Argentum Manufacturing Co.	Illinois
18.	Arrowhead Engineering Corp.	Indiana
19.	Arrowsmith Tool and Manufacturing Corp.	California
20.	Art Metal Products Co.	Illionis
21.	Brown Manufacturing Co.	Oklahoma
22.	Black Sivalls and Bryson Inc.	Oklahoma
23.	Bowman, Nicek and Associates Architecs and Engineers	Oklahoma
24.	Black and Veatch Consulting Engineer	Oklahoma
25.	Ball Reid Engineering Co.	Oklahoma
26.	Bachman Machine Co.	Missouri
27.	Bachman Machine Co.	Missouri
28.	Capital Steel and Iron Co.	Oklahoma
29.	Corken Pump Co.	Oklahoma
30.	Cincinnati Milling Machine Co.	Ohio
31.	Compbell, E. K., Company	Missouri
32.	Cooke Vacuum Products, Inc.	Connecticut
33.	Dover Corporation	Oklahoma
34.	Do All Co.	Illinois
35.	Dura Magnetic, Inc.	Ohio
36.	Eaten-quade Company, Inc.	Oklahoma
37.	Folding Carrier Copr.	Oklahoma
38.	Fife Corporation	Oklahoma
39.	Governair Corp.	Oklahoma
40.	General Floor-Craft, Inc.	New York
41.	Honeywell Inc.	Oklahoma
42.	International Environmental Corp.	Oklahoma
43.	Little Giant Pump Corp.	Oklahoma
44.	Lufkin Foundry and Machine Co.	Texas
45.	Lufkin Rule Co.	Michigan
46.	Muskogee Iron Works, Engineering Dept.	Oklahoma
47.	NUPAR Manufacturing Company Inc.	Oklahoma
48.	Northwest Industries, Inc.	Oklahoma

49.	Precision Rubber and Plastic, Inc.	Oklahoma
50.	Precise Tool and Die	Oklahoma
51.	Production Tube Co. Inc.	Michigan
52.	R & D Pattern and Foundry Co., Inc.	Oklahoma
53.	Rockwell International	Oklahoma
54.	Roberts, Paul, Machine Shop	Idaho
55.	The Roberts Brass Manufacturing Co.	Indiana
56.	Riverside Tool and Die Company	Pennsylvania
57.	Relton Corporation	California
58.	Star Manufacturing of Oklahoma	Oklahoma
59.	Star Engineering Co.	Oklahoma
60.	Stephens Manufacturing Co., Inc.	Oklahoma
61.	Sentinel Manufacturing, Inc.	Oklahoma
62.	Starret Co.	Massachusetts
63.	Snap-On Tools, Corp.	Wisconsin
64.	South Bend Lathe	Indiana
65.	The Stahl Gear and Machine Co.	Ohio
66.	The Springfield Machine Tool Company	Ohio
67.	Sprague Engineering, A Teledyne Co.	California
68.	Spitfire Tool and Machine Co, Inc.	Illinois
69.	Smith, Ed. W., Machine Works	Texas
70.	Smith Bearing Division Accurate Bushing Co.	New Jersey
71.	Texas Instrument Incorporated	Texas
72.	Tinker Airforce Base	Oklahoma
73.	Tysaman Machine Division, The Corborundum Company	Tennessee
74.	Twenty Centruy Tool Co.	Texas
75.	Twin Disc, Incorporated	Wisconsin
76.	Tempco Manufacturing	Oklahoma
77.	United Parts Co.	Oklahoma
78.	United Engineering and Foundary Co.	Pennsylvania
79.	United Spring Copr.	New York
80.	The Union Tool Copr.	Indiana
81.	Underwood, H. B., Corp.	Pennsylvania
82.	Umpco Incorp.	California
83.	Udell, Daivd, S., Inc.	Connecticut
84.	U.S. Metal Ceontainer Co, Inc.	Oklahoma
85.	Voorlas Manufacturing Co.	Wisconsin
86.	Von Arnauld Corp.	New Jersey
87.	Vogt, Henry, Machine Co., Inc.	Kentucky
88.	Vogel Tool and Die Corp.	Illinois
89.	Vlier Engineering Corp.	California
90.	Vickers Tulsa Product Division	Oklahoma
91.	Versa Product Co., Inc.	New Jersey
92.	Western Electric	Oklahoma
93.	Western Machine Tool Workers	Michigan
94.	Warner Machine Products Inc.	Minnesota
95.	Warner Machine Products Inc.	Indiana
96.	Warner Manufacturing Corp.	New Jersey
97.	Warner Automatic Controls Corp.	New Jersey
98.	Washington Iron Workers	Washington
99.	Washmoble	New Jersey
100.	Waltz Falcon Equip., Inc.	Pennsylvania

101.	Walz and Krenzer, Inc.	New York
102.	Walsh Press and Die Co.	Illinois
103.	Ziese Manufacturing Co.	Oklahoma

VITA

Mohammad Amon Rashiq

Candidate for the Degree of

Specialist in Education

Thesis: NEED FOR NATION-WIDE REVISION IN MECHANICAL DRAWING CURRICULUMS TO MEET METRIC STANDARDS

Major Field: Vocational-Technical and Career Education

Biographical:

Personal Data: Born in Kabul, Afghanistan, June 5, 1934, the son of Mohammad Zamon Rashiq.

Education: Graduated from the Afghan Institute of Technology in December, 1953. Attended Technologisk Institute, Copenhagen, Denmark, July, 1956 - January, 1958; received Bachelor of Science degree in Industrial Education from Southern Illinois University in December, 1969; completed the requirements for Specialist in Education degree at Oklahoma State University in December, 1975.

Professional Experience: Taught machine technology, mechanical drawing, material and processes, metallurgy and manufacturing processes at Afghan Institute of Technology, 1953-1962; head of the machine department, 1963-1966; assistant director for academic affairs of Afahan Institute of Technology, January, 1972 - December, 1973.